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Numerical continuation of amplitude-modulated rotating waves in sheared annular electroconvection

We investigate amplitude-modulated rotating waves (often referred to as amplitude vacillating flow) using numerical bifurcation methods based on time-integration. In particular, we study these flows as they occur in a model that simulates the flow of a liquid crystal film suspended between two annular electrodes, and subjected to an electric potential difference and a radial shear. This system is a close analogue of some laboratory-scale geophysical flow experiments (e.g. the differentially-heated rotating annulus), and to simplified models of the rotating equatorial regions of planetary atmospheres and planetary interiors. Although sheared annular electroconvection shares many characteristics with its geophysical counterparts, including their SO(2) symmetry, a crucial difference is in the two-dimensional nature of electroconvection. In particular, because the liquid crystal that is employed is in smectic A phase, its motion can be effectively modelled using the 2-D incompressible Navier-Stokes equations coupled with an equation for charge continuity.

The numerical method uses a Newton-Krylov approach for the continuation of solutions, and linear stability analysis of a flow map is used to identify the flow transitions that result due to changes in the model parameters. The amplitude-modulated waves equilibrate via a transition from rotating waves, and lose stability via a symmetry-breaking bifurcation. An appropriate choice of preconditioner enables the computation of the solution branch of modulated waves through a large range of parameter values regardless of the stability of the solutions.